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THE STUDY OF ANIMAL VARIATION.

Materials for the Study of Variation, treated with especial regard to Discontinuity in the Origin of Species. By W. Bateson, M.A., Fellow of St. John's College, Cambridge. (London: Macmillan and Co., 1894.)

MR. BATESON is to be congratulated on the completion of the first part of his work on variation in animals, which treats of variation in the number and position of organs forming parts of linear or symmetrical series. Variation in the structure of such organs is only partially dealt with, a fuller account being promised in a future volume. The present work may be divided into two parts—one purely descriptive, the other critical. These require separate notice.

It is impossible in a short space to give a proper account of the information brought together in the purely descriptive part of the book. Mr. Bateson has carefully examined many of the principal European collections, both public and private, and has in other ways collected a great store of original matter, which alone would make a respectable volume. In addition, he has compiled a series of abstracts, containing the essentials of a large number of records made by others. The labour expended upon the work of compilation alone may be gathered from the list of authors referred to, which contains some six hundred names.

The facts recorded are grouped in numbered paragraphs, on a system which makes reference to individual cases easy; the descriptions are for the most part admirable, and they are supplemented, where necessary, by adequate woodcuts. Full references are given, either to the actual specimens described, where such reference is possible, or to the source from which descriptions are quoted.

The first twelve chapters deal with organs forming parts of linear series—such as the ribs, vertebræ, or teeth of vertebrates, and similarly "repeated" structures in other animals. In these chapters special attention is drawn to cases of variation, such as the assumption by a cervical vertebra of the characters proper to a dorsal vertebra; and many remarkable examples of analogous phenomena are given. For variation of this kind, in which an organ in one region of the body is "made like" a serially homologous organ in an adjacent region, the convenient word "homœosis" is proposed. Another interesting group of cases is described as showing that the number of specialised organs in a series may be altered by a process of actual division, such as that by which an increase in the number of eyes is effected in Planarians.

The thirteenth and fourteenth chapters deal with increase and reduction in the number of digits in the vertebrate limb, and should be read in connection with the twentieth and twenty-first chapters, where closely analogous phenomena, leading to duplication of arthropod appendages, are described. The wonderful relations of symmetry, which are shown to hold in so many cases between the "normal" and the "extra" limbs, have been shortly described by Mr. Bateson on previous occasions; but the fuller statement here given forms perhaps the most interesting portion of the book.

The remaining chapters deal with variations in radial series, such as those formed by many organs of cœlenterates and echinoderms, and with cases which involve the doubling of structures normally single, or the fusion in the middle line of organs which are normally bilateral and paired.

Such in bare outline is the subject-matter of the descriptive portion of the book. No quotation of isolated passages is attempted, because no such proceeding could give an adequate idea of its importance. The whole work must be carefully read by every serious student; and there can be no question of its great and permanent value, as a contribution to our knowledge of a particular class of variations, and as a stimulus to further work in a department of knowledge which is too much neglected. It is to be hoped that Mr. Bateson will not rest content with his already great achievement, but will proceed with his promised second volume, which will be eagerly looked for by those who read the first.

If the criticism and enunciation of opinions had been performed with the same care as the collection of facts, the commentary which runs through the book would have gained in value, and several inaccuracies, due partly to want of acquaintance with the history of the subject, would have been avoided. The only contention which can here be noticed is that alluded to on the title-page, namely that variation frequently proceeds in such a way that changes in an organ occur only by steps of definite and measurable magnitude; and that discontinuous variation of this kind is necessary for the evolution of new species. In Mr. Bateson's words:

> "The first question which the study of variation may be expected to answer, relates to the origin of that discontinuity of which species is the objective expression. Such discontinuity is not in the environment; may it not, then, be in the living thing itself?"

The statement that discontinuity is not in the environment, is justified as follows:

> "Here then we meet with the difficulty that diverse environments often shade into each other insensibly, and form a continuous series, whereas the specific forms of life which are subject to them on the whole form a discontinuous series. . . . Temperature, altitude, depth of water, salinity, in fact most of the elements which make up the physical environment are continuous in their gradations," and so on.

Here the reference is only to the physical conditions which form a part of the environment affecting animals. That these physical conditions do often form a "continuous series" is no doubt true, although it is also true that in a large number of cases they do not. But Darwin, Wallace, and the greater number of subsequent writers on the doctrine of natural selection, agree in believing that the most important part of the environment against which a species has to contend consists of other living things. This view is dismissed in the following short foot-note:

> "It may be objected that to any organism the other organisms coexisting with it are as serious a factor of the

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> environment as the strictly physical components; and that inasmuch as these coexisting organisms are discontinuous species, the element of discontinuity may thus be introduced. This is true, but it does not help in the attempt to find the cause of the original discontinuity of the coexisting organisms."

Now since the deposition of the earliest palæozoic rocks animals have demonstrably been surrounded by such "discontinuous" organic environment. The statement, that the environmental conditions "form a continuous series," is therefore untrue of all animals known to us. If it has ever been true, we cannot know. The question, whether the first living things which appeared upon the earth were alike or not, is as unprofitable as speculation about the beginning or the ending of any part of the order of things from which our experience is derived must always be.

These preliminary arguments in favour of Mr. Bateson's main contention therefore fail, when applied to any part of the process of evolution of which we can know anything. It remains to consider what experimental evidence is brought forward to prove that variation is in fact "discontinuous" in any living animals.

No definition of what exactly is meant by "discontinuous" variation is given; and the conception adopted is difficult to grasp, since such domestic animals as the bull-dog are taken as examples of its occurrence. It will therefore be necessary to examine the treatment of some special group of variations: and for this purpose the chapters on teeth may be selected. The question is propounded—

> "What is the least size in which a given tooth can be present in a species which sometimes has it and sometimes is without it?"

And it is remarked that—

> "Considered in the absence of evidence it might be supposed that any tooth could be reduced to the smallest limits which are histologically conceivable; that a few cells might take on the character of dental tissue. . . . Indeed, on the hypothesis that variation is continuous, this would be expected."

Mr. Bateson considers his evidence sufficient to show that "the least size of a tooth is different for different teeth and for different animals," and that therefore variation in the teeth of those animals discussed by him proceeds by integral steps, the magnitude of the step differing in different cases. But he gives no evidence that he has ever looked for teeth reduced to the smallest histological limits. The greater number of observations recorded are made upon dry skulls, in which such rudiments could not be demonstrated. It is notorious that in many animals, such as marsupials and whales, a whole set of teeth exists, which can only be demonstrated by careful histological examination of the entire jaw, at a definite period in the life of these animals. But more important is the fact that teeth have been demonstrated, consisting of a few cells, which have hardly progressed beyond the histological condition of an enamel germ, in several of the animals used by Mr. Bateson to support his view. These cases (*Cercopithecus*, probably *Cynocephalus*, the dog, and the cat) have been completely overlooked by Mr. Bateson; and similar cases in other vertebrates have been recorded. The condition, which is said to be necessary on the hypothesis that variation is continuous, does, therefore, in fact occur; and the contention as to the least possible size of particular teeth fails.

In somewhat similar cases Mr. Bateson lays stress upon the rarity of slight variations, as compared with more considerable abnormalities. In the present case, few persons have examined the jaws of mammals in such a way as to enable them to find the smaller abnormalities, and there is no evidence worth discussion which shows whether they are rare or not. The only case in which large numbers of jaws have been examined by proper methods is that of man, in whom a fourth molar tooth is commonly present as a mere uncalcified rudiment, the cases in which this extra tooth becomes calcified and breaks through the jaw being rarer in proportion to the perfection of the extra tooth. A similar continuous series of variations is presented by the "wisdom tooth," which is most commonly a fairly perfect molar, cases of imperfection being rarer in proportion as the tooth approximates to the condition of "a few cells," hardly "taking on the character of dental tissue" at all, which it does occasionally assume. It is therefore curious, that in commencing his attempt to exhibit the discontinuity of dental variation, Mr. Bateson should dismiss the case of human teeth with the remark—

> "I do not know that among these human variations are included phenomena different in kind from those seen in other groups, except perhaps certain cases of teeth united together."

Surely variation which proceeds by integral steps of the magnitude of a tooth may justly be held to differ in kind from variation which proceeds by indefinitely small gradations?

In the case of teeth, and in many other cases discussed, the method employed is not adapted to a determination of the least possible magnitude of variations. For in judging evidence based largely upon museum preparations and on printed records, it must always be remembered that there is a tendency among curators and others to regard a slight abnormality as not worth bottle, spirit, and a place on the shelf, or to think it too trivial for printed record. Anyone who has tried to obtain specimens for a museum knows that many persons will take pains to present a rare or striking specimen, who cannot be induced to send quite common things.

The only way in which the question can be settled for a given variation seems to be by taking large numbers of animals, in which the variation is known to occur, at random, and making a careful examination and record of each. Mr. Bateson's chapter on teeth, like all his chapters, is of great interest, and will doubtless serve to throw important light on many things. But a careful histological account of the jaws of five hundred dogs would have done more to show the least possible size of a tooth in dogs than all the information so painfully collected. And so in many other cases.

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